State-of-the-Art Reactor Consequence Analyses

Semi-Annual Briefing for Commission Technical Assistants

April 14, 2009

Outline

- SECY-09-0045
- Risk Communication
- Security Scenarios
- External Spray
- Upcoming Activities

SECY Information Paper

- Responds to multiple SRMs to demonstrate how we followed Commission direction
- Provides the Commission the summary results of the Peach Bottom and Surry pilot-plants
- SECY information paper includes 4 enclosures:
  1. Executive Summary to the Technical NUREG
  2. Communication Plan, rev. 3
  3. SOARCA information booklet
  4. SGI attachment

Summary of Results

- All events can reasonably be mitigated with effective B.5.b and/or SAMG implementation
- For unmitigated sensitivity cases – no LERF
- Offsite radiological releases are dramatically smaller and delayed from 1982 Siting Study (SST1)
- Latent cancer fatality predictions dominated by long term exposure from return criteria and LNT

Key Accident Progression Timing for Unmitigated Sensitivity Cases – Peach Bottom

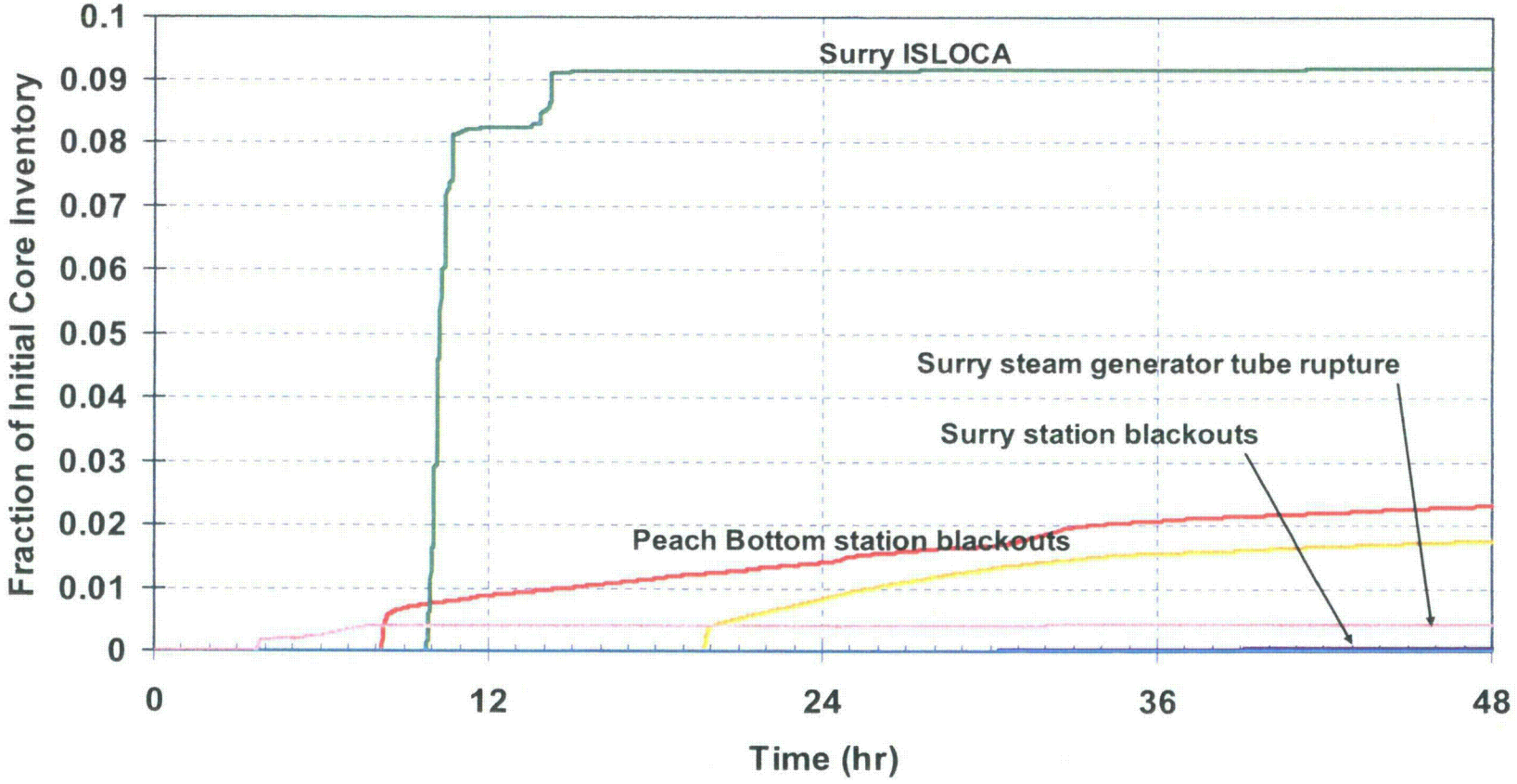
Scenario	Core damage frequency (per reactor-year)	Time to lower head failure (hours)	Time to start of release to environment (hours)
Long-term SBO	$3x10^{-6}$	20	20
Short-term SBO	$3x10^{-7}$	8	8

An unmitigated case CDF assumes probability of B.5.b mitigation is zero

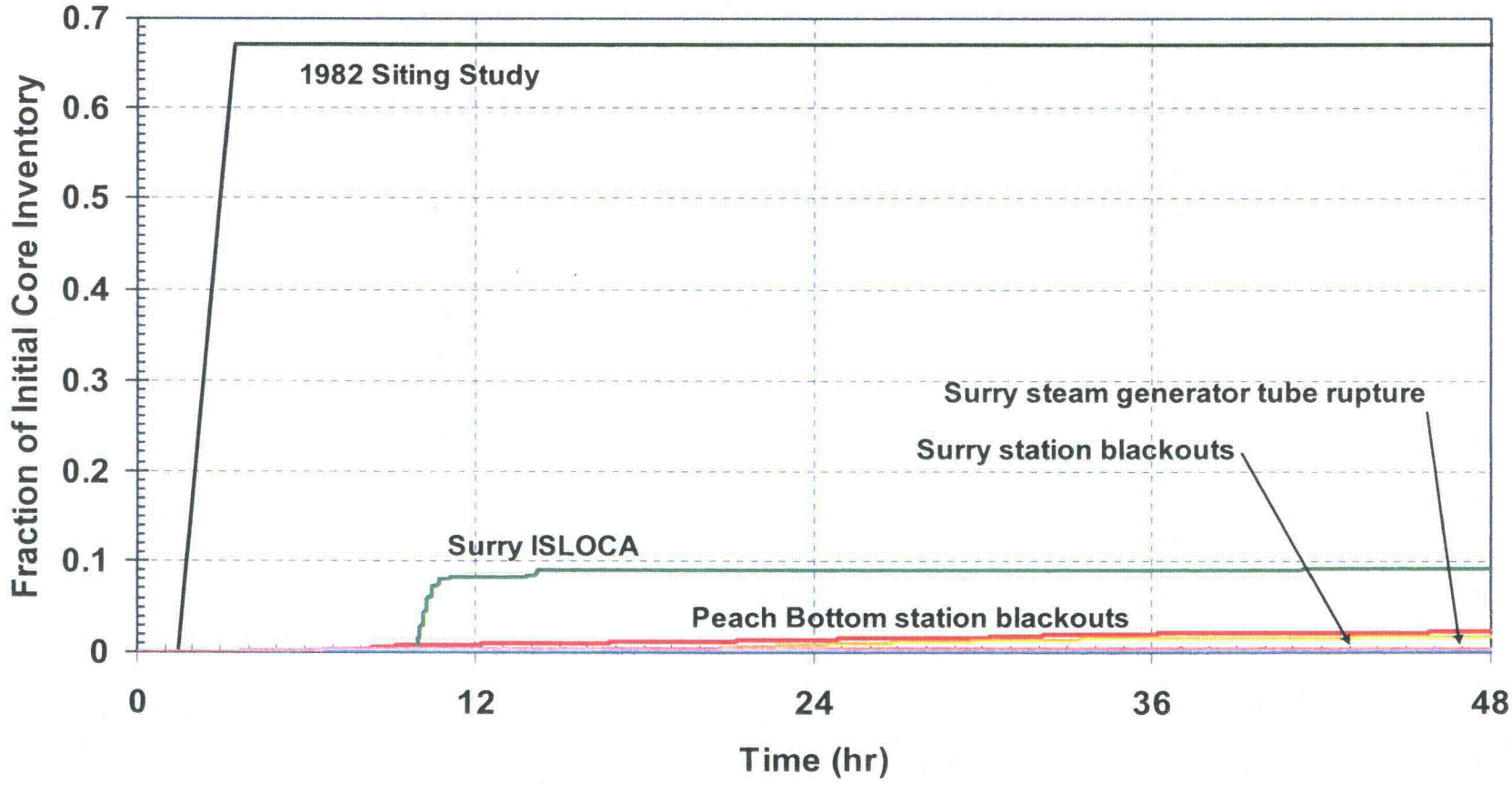
Key Accident Progression Timing for Unmitigated Sensitivity Cases – Surry

Scenario	Core damage frequency (per reactor-year)	Time to lower head failure (hours)	Time to start of release to environment (hours)
Long-term SBO	$2x10^{-5}$	21	45
Short-term SBO	$3x10^{-6}$	7	25
Thermally induced steam generator tube rupture	$5x10^{-7}$	7.5	3.5
Interfacing systems LOCA	$3x10^{-8}$	15	10

Cesium Release for Unmitigated Sensitivity Cases



Cesium Release for Unmitigated Sensitivity Cases



Health Consequences for Unmitigated Sensitivity Cases Assuming LNT – Peach Bottom

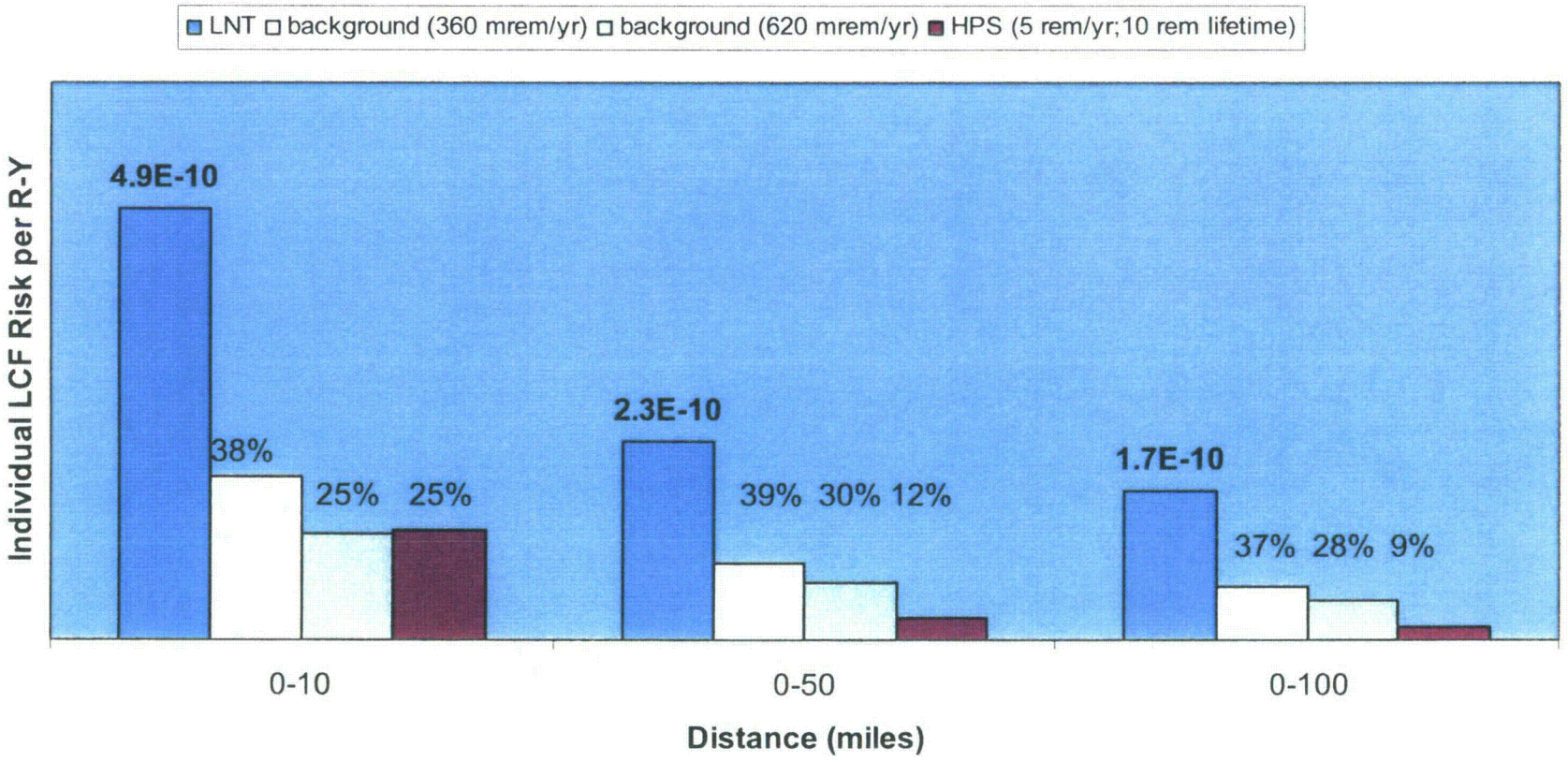
Scenario	Core damage frequency (per reactor-year)	Conditional risk of latent cancer fatality for an individual located within 10 miles	Absolute risk of latent cancer fatality for an individual located within 10 miles (per reactor-year)
Long-term SBO	3×10^{-6}	2×10^{-4}	6×10^{-10}
Short-term SBO	3×10^{-7}	2×10^{-4}	7×10^{-11}

An unmitigated case CDF assumes probability of B.5.b mitigation is zero

Health Consequences for Unmitigated Sensitivity Cases Assuming LNT – Surry

Scenario	Core damage frequency (per reactor-year)	Conditional risk of latent cancer fatality for an individual located within 10 miles	Absolute risk of latent cancer fatality for an individual located within 10 miles (per reactor-year)
Long-term SBO	2×10^{-5}	5×10^{-5}	7×10^{-10}
Short-term SBO	2×10^{-6}	9×10^{-5}	1×10^{-10}
Thermally induced steam generator tube rupture (CTFP = 0.25)	5×10^{-7}	3×10^{-4}	1×10^{-10}
Interfacing systems LOCA	3×10^{-8}	7×10^{-4}	2×10^{-11}

Surry - Unmitigated ISLOCA Risk
Dose and Distance Truncation Sensitivity



Conclusions

- Effective B.5.b mitigation and more realistic treatment of other mitigation together with detailed realistic modeling (MELCOR) has significant benefits
  - Scenarios that current PRAs say result in core damage were shown to not be core damage scenarios
    - Peach Bottom long-term SBO, short-term SBO, loss of vital ac bus E12
    - Surry long-term SBO, ISLOCA, spontaneous SGTR
  - Surry short-term SBO resulted in core damage, because we assumed seismic event was severe enough to result in CST rupture and preclude operator action for more than 3 hours
    - Currently assessing effect of seismic event on evacuation speed and offsite consequences

Conclusions

- Detailed more realistic modeling (MELCOR) without B.5.b shows more time to core damage and smaller releases
  - Improved phenomenological treatment
    - Research showed that early containment failure modes of alpha mode failure and direct containment heating were physically not feasible or of extremely low probability
  - Some scenarios, previously important in PRA, were shown to be mitigated without B.5.b equipment. (Due to longer time to utilize existing equipment) Insight being factored into new PRA.

Conclusions

- Existing PRAs indicate that CDF is dominated by external events
  - Seismic events not well quantified – seismic PRA not required
- Neither NUREG-1150 nor SOARCA included consequence results from large seismic event with the potential to fail containment and cause SBO and LOCA
  - Discussed in December 2008 TA brief
  - Issue to be addressed in a separate research program

Risk Communication

- Major element of project reflecting Commission interest
- Latest risk communication principles for a diverse audience
- Communication Plan and Information Booklet developed by communications specialists in OPA, EDO, RES (with technical content expert input from all Offices)

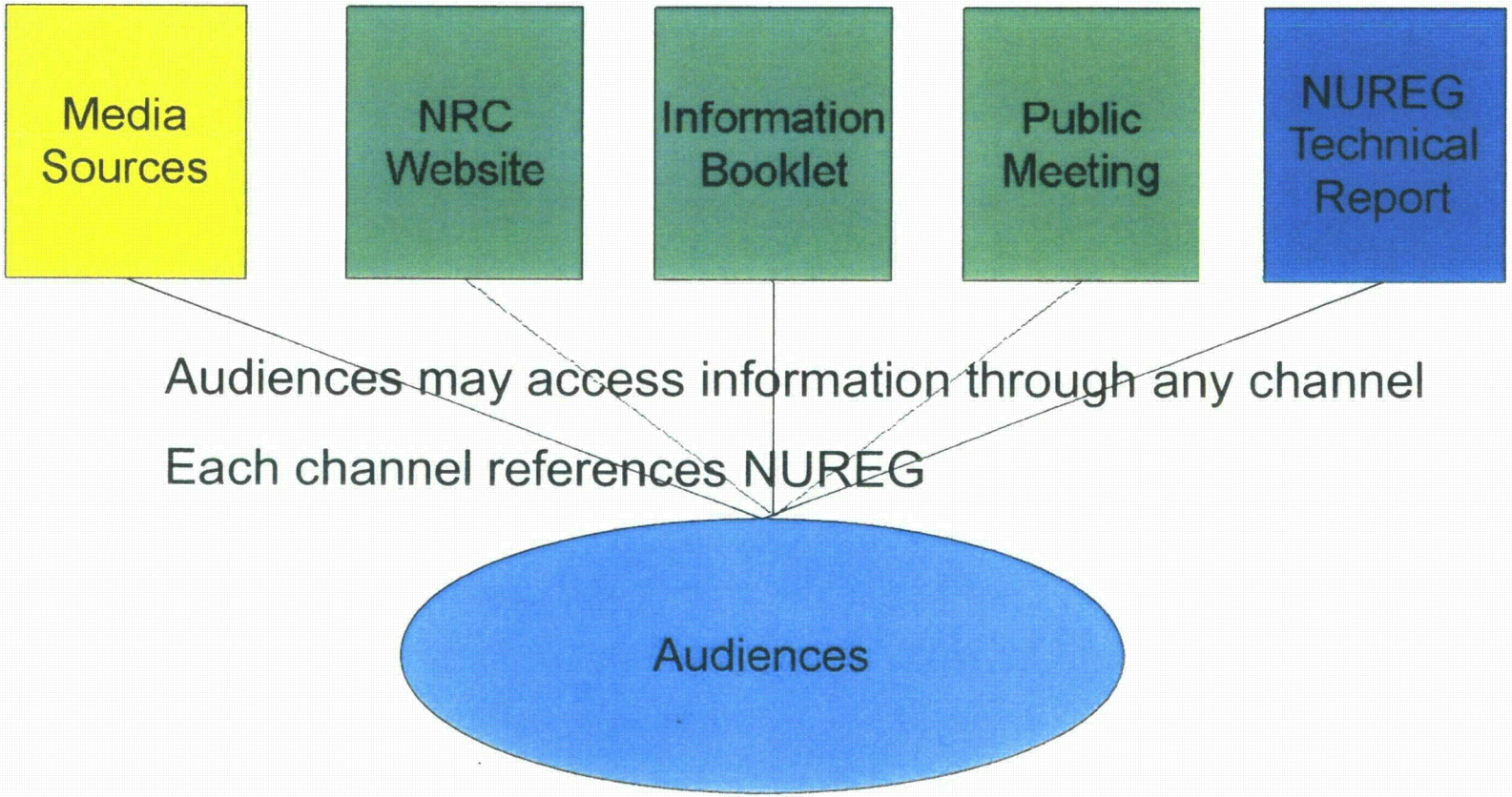
Target Audience

- People motivated to seek out this information will appreciate our efforts to be transparent, comprehensible, and "information-rich"
  - Interested citizens
  - Congress
  - Advocacy groups
  - Federal and State agencies
  - Nuclear industry
  - NRC personnel
- Focus group for testing achievement of communication objectives

Risk Communication Objectives

- *Our knowledge objectives for the audience*
  - understand more realistic consequences should an accident occur
  - understand that NRC and industry have made many improvements in nuclear plants
  - understand how the SOARCA project was conducted including basic risk analysis and modeling principles
  - understand how accidents might occur at nuclear plants
- *Our trust objectives for the audience*
  - believe that the NRC works to ensure safe operation of nuclear power plants
  - believe that NRC research provides information to support the mission
  - believe that the SOARCA project is credible

Make SOARCA Methods and Results Transparent



Build Credibility

- Forthcoming external peer review
- Cross reference public communication (e.g.,information booklet) with technical report
- SOARCA is a research project that provides information to support NRC mission
  - Connect SOARCA information to NRC regulatory activity
  - Ex. Describe accident progression alongside background information about how reactors work and description of "General Design Criteria for Nuclear Power Plants" from 10 CFR 50, Appendix A

Communication Plan: Public Rollout - Early 2010

- Early briefings on results to Regional and HQ staff
- Press release to coincide with the release of the SOARCA results; Chairman potentially holds a press briefing (e.g., National Press Club)
- Public website update
- Briefings on results to participating licensees
- All-Agreement States and Non-Agreement States letter
- Public release of NUREG and the NUREG/BR information booklet
- Public Workshop
- Regulatory Information Conference - 2010 RIC

Security Scenarios

- Separate slides containing Safeguards Information

SOARCA-Related Effort

- One mitigation measure that may mitigate the release is onsite external spray
  - B.5.b requirement – minimum of 200 gpm spray to mitigate a release
  - April 14, 2006 SRM that approved SOARCA also directed separate RES activity to quantify benefit for mitigating release
  - Test results using same spray nozzle purchased by Peach Bottom and Surry
    - Low decontamination factor (near 1)
    - But initial plume height could also be lowered to the ground
  - Analysis of Peach Bottom and Surry station blackouts showed no substantial reduction in offsite consequences

SOARCA-Related Effort

- Insight gained
  - Spray flow rate (300 gpm) tested is insufficient to mitigate release
    - Low decontamination factor
    - Small release area covered
    - Wind may blow spray away from leak location
    - Specific leak location may not be known
    - Not effective in cooling high energy plume
    - Cost of setting up spray (lost time, exposure of response personnel) questionable
- Staff considering other options – to be discussed in separate TA briefing – July?

Upcoming Activities

- Complete technical NUREG (4 volumes) – May
- Start Peer Review – June
- Start Uncertainty Study – June
- Brief ACRS – July